

REMARKS

Claims 1-4, 8-10 and 17 have been examined. Claims 5-7, 11-16, and 18 have been withdrawn from consideration. New claim 19 has been added. Thus, pending claims are claims 1-4, 8-10, 17, and 19.

Claim 1 has been amended. Support for the amendments to claim 1 and for new claim 19 is found, for example, in Fig. 1 of the present specification. Fig. 1 shows that the drift region is disposed adjacent to the channel region and partially below the gate electrode and extends below the drain region. No new matter has been added.

Claim Rejections – 35 USC §103(a)

Claims 1-4, 8-10 and 17 are rejected as being unpatentable over Blanchard. Applicants respectfully submit that Blanchard does not render the present invention as claimed obvious for the following reasons.

Blanchard teaches an LDMOS with a shallow N⁻ lightly doped drain (LDD) extension region connected to an N⁺ drain region. By this, the peak electric field near the drain boundary is reduced (Fig. 5A, column 6, lines 25-31). Further, Blanchard discloses increasing the doping concentration of the drain region below the gate (column 1, lines 45 to 52). However, Blanchard does not disclose the below bolded feature of amended claim 1:

1. (Amended) A semiconductor device comprising a source region, a channel region, a drain region, a gate electrode disposed above the channel region, and **a drift region disposed adjacent to the channel region and extending to and below the drain region,**

wherein the drift region is formed shallowly at least below the gate electrode but formed deeply in a neighborhood of the drain region.

amended

It is suggested in the Office Action that Fig. 2F portion of the drain with a shallower implant is equivalent to a drift region between the channel region and the drain region. However, Blanchard does not teach or suggest a drift region as claimed in claim 1. Blanchard

Refer to FIG. 1E & F NOT 2F - 1F

teaches a body region 124 (column 4, line 63; Fig. 2F) and a source region 126 (column 5, line 1; Fig. 2F) sandwiching a channel region, which is formed below the gate electrode 122. It does not teach or suggest a drift region that extends from the channel region to and below the drain region and that is formed shallowly at least below the electrode gate but formed deeply in a neighborhood of the drain region.

In the present invention, the drift region below the gate electrode is made shallower below the gate electrode so that relatively high voltage is not provided to the channel side. This results in a very high breakdown voltage. Consequently, the dopant concentration can be set high to achieve a low on-resistance. (See page 2, lines 13 to 25 and page 4, lines 2 to 5 and page 4, line 18 to page 5, line 1 for further explanation regarding RESURF operations).

In Blanchard, the drift region as claimed in amended claim 1 and the above effects are not taught or suggested. Thus, a person of ordinary skill in the art would not have found obvious the present invention as claimed in claim 1.

Claim 2 is also not made obvious by Blanchard. Claim 2 recites:

2. A semiconductor device comprising:
- a first conductivity type well region formed in a first conductivity type semiconductor substrate;
 - a gate electrode formed on the substrate via a gate insulating film;
 - a first conductivity type body region formed to be adjacent to the gate electrode;
 - a second conductivity type source region and a channel region formed in the first conductivity type body region;
 - a second conductivity type drain region formed at a position remote from the first conductivity type body region; and
 - a second conductivity type drift region formed shallowly from the channel region to the drain region, at least below the gate electrode, and formed deeply in a neighborhood of the drain region.**

The above bolded feature of claim 2 is neither taught nor suggested by Blanchard. Blanchard for the same reason as claim 1. Thus, a person of ordinary skill in the art would not have found obvious the invention as claimed in claim 2.

Furthermore, Blanchard does not teach or suggest a feature of claim 3 that "the second conductivity type drift region is formed by implanting at least two kinds of second conductivity type impurities which have different diffusion coefficients and at least one kind of first conductivity type impurity which has a diffusion coefficient substantially equal to or larger than the diffusion coefficient of at least one kind of second conductivity type impurity...." The effect of this is to create (1) a deep drift region where one, second conductivity type impurity with a greater diffusion coefficient is made to penetrate deeper into the substrate and (2) a shallow drift region where the second conductivity type impurity in the deeper region is canceled by the first conductivity type impurity. Blanchard in column 4, lines 2 to 7, gives the dose and the energy needed to form the boron implanted p+ diffusions 106. Blanchard does not teach or suggest the compositions of at least three types of conductivity type impurities that make up the drift region with deep and shallow parts as claimed in claim 3. Thus, a person of ordinary skill in the art would not have found obvious the invention as claimed in claim 3.

Blanchard also does not teach or suggest a feature of claim 4 that "the second conductivity type drift region is formed by implanting an arsenic ion and a phosphorous ion as the second conductivity type impurities into an overall surface of a region serving as a drift region and selectively implanting a boron ion as the first conductivity type impurity only into a region in a neighborhood of the source region." In Blanchard, arsenic is used to create a source region 126 (column 4, line 66 to column 5, line 3) and boron is used to create a body region 124 (column 4, lines 61 to 65). Blanchard does not teach or suggest using arsenic, phosphorous and boron to create a drift region as claimed in claim 4. In column 10, lines 1 to 5, Blanchard suggests that arsenic may be replaced with other antimony implants or other dopants may be changed to other species. However, again it does not teach or suggest using arsenic, phosphorous, and boron together to make the drift region. Thus, at least for the foregoing reason, claim 4 is not made obvious by Blanchard.

With respect to claims 8 and 9, Blanchard does not teach or suggest a second MOS transistor with a low concentration source-drain region formed adjacent to the second gate electrode, a high concentration source-drain region, and a middle concentration source/drain region. Blanchard in column 6, lines 25 to 35, merely mentions a lightly doped drain extension

regions without giving any details. It is submitted that a person of ordinary skill in the art would not have been able to derive the feature of claims 8 and 9 from such a description.

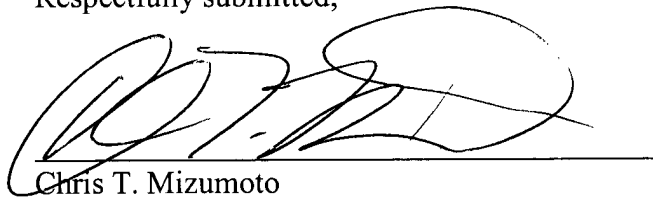
It is added that claims 8 and 9 that have the same drift region feature as claim 1 is not made obvious at least for the same reason as claim 1. Additionally, dependent claims 3, 4, 10, 17 and 19 are not made obvious at least for the same reason as independent claims 1, 2, 8, or 9.

Attached is a marked-up version of the changes being made by the current amendment.

Applicant asks that all pending claims (claims 1 to 4, 8 to 10, and 17 to 19) be allowed. Applicants submit that there are no fees due. However, if necessary, please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: September 19, 2001



Chris T. Mizumoto
Reg. No. 42,899

Fish & Richardson P.C.
45 Rockefeller Plaza, Suite 2800
New York, New York 10111
Telephone: (212) 765-5070
Facsimile: (212) 258-2291

Version with markings to show changes made

In the claims:

Claim 1 has been amended as follows:

1. (Amended) A semiconductor device comprising a source region, a channel region, a drain region, a gate electrode [formed] disposed above [on] the channel region, and a drift region [formed between] disposed adjacent to the channel region and extending to and below the drain region,

wherein the drift region is formed shallowly at least below the gate electrode but formed deeply in a neighborhood of the drain region.